UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

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OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

MEMORANDUM

SUBJECT: Percent Crop Treated for New Use (PCTn): Aldicarb (098301) Use on Citrus

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Product Review Panel Date: [DATE \@ "MMMM d, yyyy"]

I. SUMMARY

The Biological and Economic Analysis Division (BEAD) is providing the upper-bound estimates of the percent crop treated for a new use (PCTn) of aldicarb to support refinement of the aldicarb dietary risk assessment. The assessment is in response to a petition from the registrant, AgLogic, for new use on citrus in Florida and Texas.

BEAD used a modified market leader approach, which identifies the active ingredient with the highest percent crop treated (PCT) as the current insecticide market leader used on citrus as the PCTn for aldicarb. The recommended average and maximum PCTn for aldicarb, respectively, are as follows: grapefruit (79%, 87%) and oranges (75%, 80%). BEAD examined the relevant information on potential economic impacts from pests, pest spectrum of the proposed new use of aldicarb, and insecticide resistance to conclude that aldicarb does not face typical market penetration barriers, and the actual PCT for aldicarb could exceed the PCTn in the next five years.

II. ESTIMATION OF PERCENT CROP TREATED FOR A NEW USE

EPA estimates of the percent crop treated for a new use (PCTn) of aldicarb represents the upper bound of use expected during the pesticide's initial five years of registration. The PCTn recommended for use in the chronic dietary assessment is calculated as the average percent crop treated (PCT) of the market leader or leaders, (i.e., the one(s) with the greatest PCT) on that use site over the five most recent years of available data. The PCTn recommended for use in the acute dietary assessment is the maximum observed PCT over the same period. Comparisons are only made among pesticides of the same pesticide type (e.g., the market leader for insecticides on the use site is selected for comparison with a new insecticide). The market leader included in the estimation may not be the same for each year since different pesticides may dominate at different times.

Typically, EPA uses USDA National Agricultural Statistics Service (NASS) as the source data, because it is publicly available and directly reports values for PCT, and supplements with proprietary agricultural market research data (AMRD). In this unique case, however, AMRD was the primary source because it provides pest-specific usage data that is unavailable from NASS. PCT was calculated based on reported acres treated and acres grown data.

A retrospective analysis to validate this approach shows few cases where the PCT for the market leaders were exceeded. Further review of these cases identified factors contributing to the exceptionally high use of a new pesticide. To evaluate whether the PCTn for aldicarb could be exceeded, EPA considered whether there may be unusually high impacts from pests, as indicated in emergency exemption requests for aldicarb; whether the pest spectrum of the new pesticide is broader in comparison with the market leaders; and whether pest resistance issues with past market leaders provide aldicarb with significant market potential. Given currently available information, BEAD concludes that actual PCT for aldicarb has the potential to exceed the estimated PCT for a new use in citrus during the next five years.

III. PROJECTIONS BASED ON MODIFIED MARKET LEADER APPROACH

The market leader approach is supported by an analysis of the comparison of the PCT with market leaders over the same period. After reviewing past cases in which this approach has been used, BEAD found that over 95% of the time, the new pesticide or new use of a registered pesticide is not likely to overtake the market leader for the pesticide type and crop in the first five years following registration. However, a revised approach was necessary to accurately estimate percent crop treated (PCT) for aldicarb use on citrus.

Aldicarb was previously registered on citrus but voluntarily canceled by the previous registrant due to human health risks of concern (EPA, 2011). Additionally, the pest, Asian citrus psyllid (ACP), is a relatively new invasive species that vectors a bacterial disease with major implications for citrus growers. Because aldicarb is well-known by growers and the economic impact of the pest is severe, BEAD expects aldicarb to receive more of the market share than is typically expected for a new use.

As a result, the standard market leader approach would not accurately represent expected usage. Instead, BEAD followed a targeted market leader approach to derive the PCT values presented in Table 1. Typically, the market leader approach means evaluating PCT data for the active ingredients (AIs) of a specific pesticide type (e.g., herbicides, insecticides, etc.) that dominate the market to assign a conservative upper bound PCT value for the new use. However, in this case BEAD focused the comparison of PCT values to AIs known to control psyllids.

BEAD selected AIs for analysis using pest-specific AMRD and Emergency Exemptions (Section 18 registrations) issued for control of ACP in citrus fruits (AMRD, 2013-2017; EPA, 2019; McGettigan and Alsadek, 2018). From this selection of AIs, the market leader was determined based on reported acres treated and acres grown data. Usage data for the market leader was aggregated from AMRD and NASS to generate average and maximum PCT values for the proposed new uses (Table 1). This refined approach allowed BEAD to estimate market share with respect to the target pest.

Table 1. Percent Crop Treated for New Use (PCTn) of aldicarb on citrus.

Crop	Market Leader Chemical	State	Avg PCT	Max PCT
Grapefruit	Abamectin		**79**	**87**
	Abamectin	FL	81	89
	Abamectin	TX	73	96
Oranges	Abamectin	FL only	**75**	**80**

Source: AMRD (2013-2017)

IV. ADDITIONAL FACTORS

There are three main factors BEAD considers in evaluating the likelihood that use of a newly registered chemical or a new use will exceed the PCT for new uses: (1) the extent of pest

pressure and their economic impacts on the crops; (2) the pest spectrum of the new pesticide in comparison with the market leaders; and (3) resistance concerns with the new pesticide and the market leaders. High pest pressure with the lack of registered controls could indicate significant demand for a new chemical. Emergency exemptions under section 18 of FIFRA are a good indicator in regard to these situations. On the other hand, it would be relatively difficult for a new active ingredient to gain a large portion of the market if a) it competes with the market leader(s) or others that have been extensively used for pest control including the same target pest(s), b) its new use is limited, for example, registered only for a single pest, and/or c) it is labeled for pest(s) of minor economic concern. Finally, if the target pests are developing resistance to the market leader(s), it could indicate an advantage for the new active ingredient in the market.

Discussion of Factors Relevant to the PCTn of Aldicarb on Citrus

1. *Pest impacts*: Asian citrus psyllid (ACP), a nonnative hemipteran species, is considered the most important pest of citrus worldwide (Grafton-Cardwell et al. 2013). It was first detected in Florida and Texas in 1998 and 2001, respectively (French et al. 2001, Bové 2006). Nymphs feed only on a tree's newest growth or flush, while adults can feed on all foliage (Grafton-Cardwell et al. 2013). Like many other hemipterans, they use their piercing-sucking mouthparts to extract phloem sap. During ingestion, ACP also injects toxins that cause foliar distortions, especially of new flush (Diepenbrock et al. 2019).

   ACP vectors the bacterial pathogen '*Candidatus* Liberibacter asiaticus,' which causes the citrus disease huanglongbing (HLB) (Grafton-Cardwell et al. 2013, Grafton-Cardwell 2018). The disease was first documented in Florida and Texas in 2005 and 2012, respectively (Bové 2006, Bográn et al. 2012) and is considered widespread in Florida (Coy and Stelinski 2015). In Florida, pathogen acquisition rates observed in ACP adults that feed on infected trees are variable (37.5-100%), with an average acquisition rate of 68.8±25.3% (±SD) (Coy and Stelinski 2015).

   HLB affects nearly all commercial citrus species and cultivars (Bové 2006). The pathogen is restricted to the phloem, where it blocks the movement of sugars to the roots and results in poorly developed root systems (Dala-Paula et al. 2019). Trees with HLB subsequently exhibit thinned canopies, asymmetrical mottled leaf patterns, and deformed fruits that do not ripen, remaining green and bitter (Bográn et al. 2012, Dala-Paula et al 2019). There is no treatment for HLB, and trees die within five to eight years (Grafton-Cardwell et al. 2019). Preventing infection by ACP is the only control option for HLB (Bové 2006). However, this is challenging due to pest biology and behavior (Grafton-Cardwell et al. 2013). Psyllid populations increase quickly, and adult ACP disperse over a large area if unmanaged. ACP is not controlled by any one insecticide, further compounding control efforts of HLB (Grafton-Cardwell et al. 2019).

   In the year prior to the detection of HLB in Florida, approximately 576,000 acres of bearing trees (all citrus varieties) produced 7.6 million tons of fruit (Florida Citrus Statistics 2017-2018). Bearing acreage and production has decreased to 401,000 acres and 2.2 million tons of fruit as of 2017-2018. In Texas, HLB was detected during the 2011-2012 crop year when

25,000 acres of bearing trees (all varieties) produced 252,000 tons of fruit. Bearing acreage decreased to 24,400 acres in 2017-2018, but production had increased to 272,000 tons (Florida Citrus Statistics 2017-2018). In the most recent USDA census, non-bearing acreage is small in both Florida and Texas at approximately 28,000 and 1,600 acres, respectively (USDA NASS 2017).

Clothianidin, a neonicotinoid, is the only insecticide to date to have received FIFRA section 18 emergency exemptions for control of ACP in FL and TX in 2014 and 2016, respectively (EPA, 2019). However, clothianidin has not usurped the PCT of the market leader, abamectin, for control of ACP.

2. *Pest spectrum*: Aldicarb is a soil-applied insecticide / nematicide that belongs to the carbamate group (IRAC Group 1A). Carbamates are broad-spectrum chemicals that work as acetylcholinesterase inhibitors. Aldicarb is rapidly taken up and translocated throughout plants and oxidized into sulfone and sulfoxide metabolites, which are responsible for aldicarb's insecticidal properties (Baron 1994). Aldicarb is used on other crops such as cotton, soybean, and sweet potato to manage many nematode and hemipteran pests and a few species of thrips, beetles, flies and mites.

   Aldicarb's proposed label for citrus includes ACP, aphids, whiteflies, citrus red mite, citrus rust mite, and the Texas citrus mite. The market leader, abamectin, is registered for control of ACP, broad mite, citrus bud mite, citrus rust mite, twospotted spider mite, citrus leafminer, and citrus thrips. While abamectin is not registered for control of aphids or whiteflies, there are multiple other insecticides already used in citrus to control those pests when they are of issue, and BEAD considers ACP to be the primary target for proposed aldicarb registration in citrus.

3. *Resistance concerns*: Insecticide resistance to the market leader, abamectin, has been reported on a multitude of pests on various crops; citrus pests with reported resistance to abamectin include the twospotted spider mite and the citrus red mite (APRD, 2019). Insecticide resistance to aldicarb has been reported on the Colorado potato beetle, twospotted spider mite, and vegetable leafminer (APRD, 2019), and while the twospotted spider mite is a pest of citrus, it is not included on the proposed aldicarb label. Aldicarb could be used as a miticide in abamectin-resistant populations of citrus red mite; however, this scenario will likely not significantly increase aldicarb's PCT, as spider mites only constitute a fraction of target insecticide applications when compared to ACP (AMRD 2013-2017). As ACP resistance has not been reported to aldicarb nor abamectin, aldicarb has no significant advantage over abamectin with regard to target resistance concerns.

   BEAD broadened the scope to identify resistance to other carbamates (cross-resistance) within field populations of ACP. The only carbamate presently registered for psyllids in citrus is carbaryl. In Florida, Kanga et al. (2016) exposed field-collected and lab-susceptible adult ACP to diagnostic concentrations of multiple active ingredients, including carbaryl. Thirty percent of ACP adults were alive after exposure to carbaryl for 24 hours (Kanga et al. 2016). It is important to consider the potential for cross-resistance to aldicarb with its usage in citrus to manage ACP.

V. CONCLUSIONS/RECOMMENDATIONS

BEAD determined that the aldicarb average and maximum PCTn values, respectively, for the requested crops are as follows: grapefruit (79%, 87%) and oranges (75%, 80%). BEAD considered all available relevant information, including the significance of impacts from pest pressure, pest spectra of the current market leader and aldicarb, and any reports of insecticide resistance. BEAD concludes aldicarb does not face typical market penetration barriers, and the actual PCT for aldicarb in citrus could exceed the PCTn in the next five years.

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